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Getting The Most From Lenticular Imaging

v 2.2

Preface

As I write this, in August 2006, 3D and 2D Lenticular imaging is at the stage that Digital Photography was in 1988, when I first got involved with that. What it took to make digital photography easy and relatively inexpensive was a whole bunch of people getting involved in it. This showed manufactures that there was a market for digital photography equipment and programs and printers and printer paper and inks, etc., all of which helped drive prices down and increase the quality of equipment and supplies, and of digital pictures. Additionally, the process got a lot easier to do. When many people are involved with Lenticular imaging, the same will happen to it. This is the main reason I'm writing this ebooklet. I wrote the first published How To book on digital photography, (*Basic Digital Photography, Focal Pres, 1991*), which is now very out of print and laughably obsolete. I'd like to see how visuals change when 3D and 2D Lenticular pictures become routine.

In this ebooklet I will make suggestions and statements that professionals "in the Lenticular business" will disagree with. I am not trying to be the 3D Lenticular guru, and all I have to do to answer those experts who may disagree with suggestions and observations and statements I make is to look at my wall with my 3D pictures displayed, which were made with the information I will give below, including my way to convert 2D images to 3D images.

Finally, I want to say that over the years, the quality of my 3D images have improved greatly, due mostly to the gradual addition of the techniques and methods I describe below. I hope that over the coming years the quality of my 3D pictures will continue to increase, due to improvements in the design and manufacture of Lenticular lenses, and also to other supplies and equipment.

And now, on to the tutorial.

In this ebooklet I describe some concepts and terms used in Lenticular imaging which many readers may not be familiar with. In particular, I will describe the different types of Lenticular pictures, and what Lenticular lenses and interlacing (combining two images) are. I give you a really nifty and quick method for creating a 3D image from a 2D image. I also point you to a free (the last time I checked) interlacing program you may want to get, called Superflip. I also give practical information for preparing your images to make the best looking 2D, Lenticular 2D and Lenticular 3D images that are possible, and some

thoughts on the longevity of Lenticular images and where to buy Lenticular lenses. As time goes by, with the help of the information included with this ebook, many more people will get involved in 2D and 3D Lenticular imaging, and much more information will find its way to 2D and 3D photo message boards and chat rooms.

What is a Lenticular picture?

While Lenticular imaging sounds more sophisticated, I will refer to pictures, since that's what most of us are interested in creating. There are two different types of Lenticular pictures. One is two dimensional, and the other is three dimensional. The 2D version is often called a "**flip**" and sometimes a "**winkie blinkie**". These are the type of pictures often seen as postcards and advertising material, where one picture rapidly changes to another picture when the viewing angle of the picture changes. These flips are not limited to just two pictures replacing each other, but can involve numerous pictures changing as the viewing angle of the Lenticular lens changes. These multiple changing pictures may be similar to animation sequences, such as a series of pictures of someone walking or hitting a tennis ball. Or, they may be many different pictures, such as a car, which is replaced by a tree, then by a person, then by a flower, etc. Again, all of these pictures are in 2D.

The 3D version of Lenticular pictures almost never "flip", although they can be made to, at least slowly- a slow transition from one picture to another. But most 3D Lenticular pictures are just that, a three dimensional picture that can be seen as 3D without the use of special viewing devices or glasses or lighting. **Just look at the picture, and it's in 3D.**

How much 3D is 3D? Depending on the skill of the photographer/artist, and of the eyesight and brain wiring of the viewer, the 3D "illusion" can vary from slight to great. The 3D in a Lenticular picture is an optical illusion. A really neat one. Well, all vision can be thought of as an optical illusion. 3D Lenticular pictures are just a special type of optical illusion, in which the brain is fooled into thinking it is viewing a real, three dimensional scene. If the brain thinks it is looking at a real scene, it will tend to see that scene in three dimensions.

In order to create the optical illusion, the picture, whether a photograph, a drawing, or a painting, must be specially prepared after it is made, and it should contain **"depth cues**" to aid in the illusion. A picture of graffiti on a flat wall is not going to look as 3D as a picture that has a distinct foreground, middle ground and background, which are depth cues. Besides having depth cues in your picture, there are a number of different elements that go into creating a good 3D Lenticular picture. You will be in control of some of these, but not all.

As for those things that you won't be in control of, there is the eyesight of the viewer, and how the viewers' brain is "wired". Good 3D vision depends on good vision to start with. If a person has blurry vision, he is not going to see as good 3D in anything as someone with sharp vision. Even if the viewer has sharp vision, there are a relatively few people who will never see 3D in a 3D Lenticular picture, even though most other people will see 3D in that picture. It's just how some people's brains seem to be wired. Not to worry. Most people do see good 3D in a properly made 3D Lenticular picture. And then, there are a few others who see too much depth. Their stomachs get upset when looking at 3D Lenticular pictures which don't effect most people that way. The vast majority of people will see good 3D in a properly prepared 3D Lenticular picture, relatively few people won't see any 3D, and relatively few people will see too much 3D.

As for the type of 3D, it is usually seen as extreme depth, although elements of images coming forward, in front of the picture, are possible to make. However, this is not the type of 3D that makes you want to duck so you won't get hit by a ball thrown toward a camera. At least, not yet. In time, I'm sure it will be.

Happily, the problems of too much or too little 3D effect don't exist in 2D flips, where one image changes to another. I don't know of anyone who doesn't see the transition of one image to another. One point to consider is that if a 2D flip has too many different pictures changing from one to another, then the overall quality of the pictures will decline, simply because there is less room for all the images to share space with each other. This is similar to printing eight different same size pictures on one 8x10 inch piece of paper, compared to printing four different same size pictures on one 8x10 inch piece of paper. Each of the four pictures can be 4x5 inches in size, while each of the eight pictures can only be 2 x 2 ½ inches in size, and so lack room for detail, when compared to the detail the 4 x 5 inch images can contain.

In Lenticular imaging, bigger is usually better for both the 3D and 2D effect. However, a well thought out visual can be small and work well. For example, a small Lenticular picture of an eye which "winks" (seen as open which changes to closed and then back to open) depending on the angle it is viewed at, can look good. Such and image will work well, because the picture of the eye is simple to comprehend, and doesn't depend on a lot of detail to be understood, or look good.

To make a flip, all that is necessary are two or more digital images and interlacing software, which will put the pictures into proper form. Once interlaced by the software, the resulting file is printed and a 2D Lenticular lens is placed over the print (all discussed below).

Making a 3D Lenticular picture is (usually) considerably more complex, which is one of the reasons you don't see many 3D Lenticular images. While two

or more completely different pictures are used for a flip, two slightly different images are used for a 3D image. (Actually, it is the same image seen slightly differently.) One of the two images for 3D can be thought of as “left eye” and the other as “right eye”. These two images are approximations of what the viewer’s left eye and right eye see. One way to get the left eye and right eye views for use in a 3D Lenticular picture is to use a multi-lens “3D” camera, one that takes two (or sometimes more) pictures simultaneously through different lenses, one lens representing the left eye view (what the viewer’s left eye sees) and the other lens the right eye view (what the viewer’s right eye sees). The two lenses are separated from each other by approximately the average distance peoples’ left eye and right eye are separated from each other. After the pictures are taken, they are scanned (or uploaded if they start off as digital) and then prepared with special (interlacing) software which combines the two views, and a print is made.

Some people insist that more than two different “views” are necessary for good 3D. Not to pick a fight with these folks, I do want to use common sense. People have two eyes and see in 3D, and “old fashioned” 3D photography has successfully used two lens cameras as part of the 3D photographic process, not cameras with three or four or more lenses. (And I use a one lens camera for my Lenticular 3D.) Two lenses properly positioned are all that is necessary to create excellent 3D. Or, as described below, a one lens camera or a scan of a painting, print, etc.

Because there are very few two lens “stereo” cameras made today, and none that I know of which have the abilities and features that professional photographers want and are used to using, not many 3D Lenticular pictures start off being taken with a two lens camera. Photographers have come up with various means to use a one lens camera to simulate a two lens camera. For example, a bowl of fruit can be placed on a table, and a camera is put on a tripod and focused on the bowl. One picture is taken, and then either the bowl is moved some small distance to one side, and a second picture is taken, or an apparatus is used which allows the camera to be moved some small distance to one side, while leaving the tripod stationary, and a second picture is made. Then, the two (or more) pictures are specially combined (called interlacing) using computer software, and the resulting properly prepared picture is placed behind a Lenticular lens, which results in the optical illusion of depth. (More about this later, honest.)

Obviously, this method is not good for taking pictures of anything that is moving- not good for portraits, or street scenes, or ocean waves, or... And this method is not helpful for painters, unless they want to take multiple photographs of their art, one representing the “left eye view” and another representing the “right eye view”.

There are still other methods available. One, which I came across during a patent search, involves placing a print (photograph, painting or drawing) into a computer flat bed scanner, making a standard scan, and then moving the picture slightly to the side and making a second scan. The lens in the scanner acts as a lens on a camera, and so when the print is moved, the image recorded by the scanner is from a slightly different optical position. This method does work, but is a bit clumsy, if for no other reason than it is difficult to precisely move the print being scanned, making certain not to rotate the print even a little, and making it difficult to accurately move the print some distance. Moving the picture any old distance won't do. It must be moved a precise distance.

In any of the methods just described, the amount of 3D effect is dependent on, (among other things) the amount the two images are separated from each other. If separated by too little, there will be a limited or no 3D effect, and if separated by too much, the 3D effect will also be diminished or lost.

So, to create a 3D Lenticular picture, you could use the "take one picture of something that doesn't move and then shift the camera or subject slightly to the side and take a second view", or, "make a print and put it in a scanner and make a scan and then move the print slightly to one side and make a second scan" method, **or** you can use a program such as Photoshop to do the following: display a picture, and then go to **filter**, then **other**, then **offset**, and then choose **horizontal** pixels, then enter **8** in the space provided, then select **repeat edge pixels**, and then click **Okay**. (Leave "vertical pixels" at 0.) When the image on the screen moves a bit (all of 8 pixels), save the picture as a new file, maybe call it "right"". Then use an interlacing program (such as Superflip) to combine the two pictures. The original can be thought of as the left eye view, and the new one the right eye view. Then print the resulting combined file, and then place a Lenticular lens over the print. As for the number 8 I told you to enter, I have found that numbers from 6 to 12 work for most images.

Although this method does not use a lens (as does taking two pictures or using the lens in a scanner), it works just fine. The slightly offset two views are all that are needed, when the pictures are combined (interlaced), to fool the brain into thinking it is looking at a real 3D scene, and so the brain will see the picture as 3D. The method I've just described is fast and easy, and will work with any file. Well, maybe not one of a stick drawing. Other programs besides Photoshop are capable of "offsetting" an image.

What is a Lenticular lens?

Trying not to get technical, think of a flat piece of window glass, but made out of a clearish plastic. (All of the Lenticular lenses I've seen have a very slight

color cast. Not so great that it becomes an aesthetic problem. Don't be surprised if the Lenticular lenses you use do have a **slight** color cast to them.)

Imagine an 8 x10 inch sheet of "window plastic", instead of "window glass". One side is smooth. Perfectly smooth. The other side has long "ripples" which run parallel to each other. Depending on the lens, these ripples may be difficult to detect with your eyes, or they may be very large and noticeable. Lenses with very obvious ripples are not usually those used for 3D imaging. They are usually meant for the "flip" or "winkie blinkie" postcards and similar images.

One way to visualize these ripples is to imagine a clear soda straw. Imagine one end touching a table top, and the other end sticking straight up into the air. Now imagine that you took a razor blade and cut the soda straw down the middle, starting at the top, all the way down to the table top. This will give you two long curved sections of soda straw. On the piece of window plastic, place one of the straw sections so that the curved surface is pointing toward your face. Then place the other section of straw parallel to and touching the side of the first section. Imagine that you continue to cut soda straws lengthwise, and place the sections side by side next to each other. Eventually, the window plastic will have one side covered with these curved straw sections, all parallel and adjacent to each other. The other side of the window plastic is flat.

Each of these "soda straw" sections is called a lenticule, or lentical or lenticee, or similar name. Each lenticule is an elongated lens. The entire piece of "window plastic" with all the lenticules is one Lenticular lens. Depending on the width of the lenticules, they may be difficult to see or very noticeable . Either way, they can be felt by running your finger over them. If you run your finger along the length of the lenticules, you won't feel anything, but if you run your finger across the lenticules, from the side of one to the side of the next, you will feel the ridges.

A properly prepared (interlaced) image, usually printed on paper, is placed in contact with the **flat side** of the Lenticular lens. (The picture can be printed directly onto the flat side of the lens, but this is an offset lithography process. I don't recommend using this method with your home printer. At least, not until the proper inks are developed, and some other technical problems are worked out.) The paper print is put in contact with the flat side of the Lenticular lens. On the other side are column after column of the lenticules. These can be thought of as odd columns and even columns. The lenticules in odd columns may be optically angled slightly so only your left eye sees what is placed behind them, and the even lenticule columns may be optically angled slightly so only your right eye sees what is placed behind them. To get the 3D effect, the lenticules are <u>always</u> viewed in a vertical (up to down, top to bottom) orientation. If the lenticules are in

a horizontal (left to right) orientation, no 3D effect will be seen.

Lenses are rated by their number of lenticules per inch **(LPI),** which is also called **pitch**. I think LPI is more descriptive. I have found that the more LPI, the greater the 3D effect. Most lenses designed for 3D are at least 60 LPI lenses, although I have seen 3D 20 LPI lenses mentioned on the Internet. Other lenses which can (sometimes) be found are 40 LPI and 72 LPI and 90 LPI and 100 LPI. Photographers may want to think of these different LPI lenses as different types of film. They have different characteristics, and usually give different degrees of 3D effect. As more people get involved in Lenticular picture making, message boards will discuss the pros and cons of different types of Lenticular lenses made by different manufacturers.

Do keep in mind that Lenticular lenses come in two main varieties- those used for 2D flips and those used for 3D pictures. The optical properties of each type differ. **Make sure any lenses you buy are designed for the type of pictures you want to make.**

Once the properly prepared (interlaced) image has been properly placed in **firm contact** with the flat side of the Lenticular lens, it would seem normal to stand directly in front of the lens to see the 3D effect. Well, you can, but standing slightly to one side or the other will (usually) give a greater 3D effect. This is a product of how the Lenticular lens is designed. Some 3D lenses are “rated” to be viewed at a 25 degree or similar angle. Information like that is included, or should be, in the lens’ description. I doubt anyone actually measures the exact viewing angle when looking at a 3D Lenticular picture. And most people won’t take a step to one side or the other and turn their head toward the center of the picture. It just isn’t how we have learned to look at pictures hanging on a wall. Now that you know that standing a step or two to the side of the picture, instead of centering yourself, and then turning your head so your eyes are looking at an angel at the picture is encouraged, you’ll get used to it. You’ll enjoy seeing the different degrees of 3D depending on what angle you are, or aren’t, viewing the image from. And you’ll enjoy teaching others how to look at a 3D Lenticular image to see the greatest amount of 3D possible in that image. And how the image may change a bit as you stand at different angles and turn your head toward the center of the picture. This is something you’ve got to experience to understand.

Standing directly in front of a flip will usually show just one of the two or more pictures that make up the flip. Taking a step to one side or the other and turning your head to look at the center of the lens will change the image. Taking another step to the side may bring back the first image, or yet another one, depending on how many pictures the flip is made of.

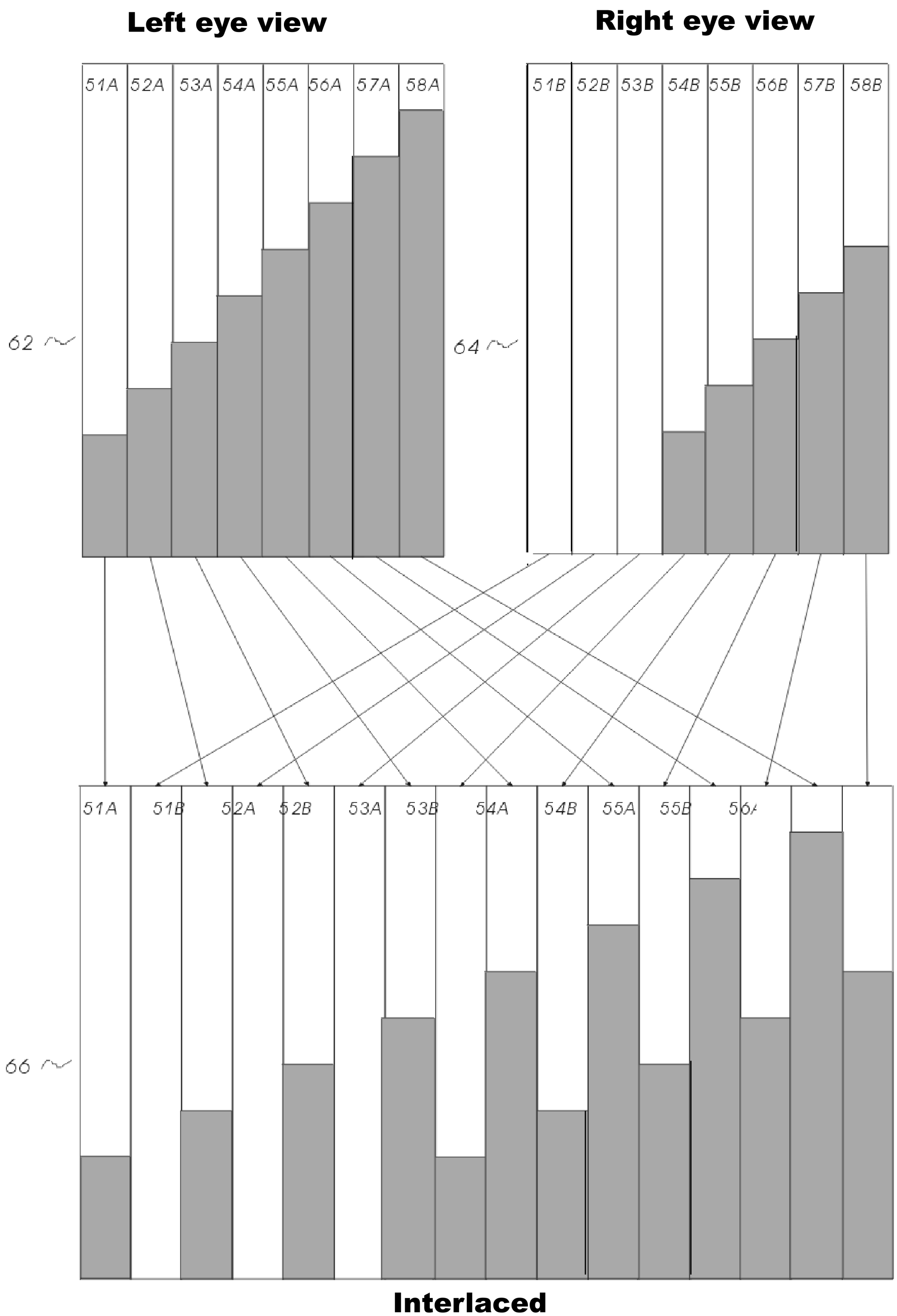
Additionally, the viewing distance varies from one type of lens to another,

and from how one person's brain processes the picture information. Also, standing closer or further from the image will effect the amount of 3D that is seen. The "perfect" viewing angle and distance will vary among people. I have found for the type of 3D art I do, and for the 60 LPI lenses I usually use, a viewing distance of 3-6 feet does it for most people.

What is interlacing?

Whether you are making flips or 3D pictures, one way or the other you will have at least two pictures. For 3D, one picture will represent the left eye view of the scene, with the other picture representing the right eye view. Somehow, the picture information from just the right eye view needs to be detected by your right eye, and the picture information from just the left eye view needs to be seen only by your left eye. This is accomplished by interlacing and the use of a Lenticular lens. Interlacing involves taking a thin vertical slice of the left eye view/picture and placing it, by an interlacing computer program, so that it will lie behind one lenticule of the Lenticular lens, which is angled to be seen by the viewer's left eye, and then a thin slice of the right eye view/picture is placed next to the left eye slice, so it will lie behind the lenticule angled so that only the person's right eye sees that small fragment of the entire picture. To help you visualize this process, I've placed a diagram liberated from my patent application below.

So, a thin slice of the left eye picture (or first picture for a flip) is placed next to a thin slice of the right eye picture (or second picture for a flip), and then another thin slice of the left eye picture is placed next to the slice of the right eye view, etc. Eventually a new file is created which has alternating vertical slices of the left eye picture and the right eye picture. These slices, when printed, are placed underneath the different angled lenticules and the 3D effect is created.


Left eye view
Right eye view
51A
52A
53A
54A
55A
56A
57A
58A
51B
52B
53B
54B
55B
56B
57B
58B
62
64
51A
51B
52A
52B
53A
53B
54A
54B
55A
55B
66
Interlaced

As for flips, picture information for one picture will lie underneath (or behind, depending on how you want to think of it) lenticules angled to be seen by one eye, and a second picture behind lenticules angled to be seen by the other eye. Below is a diagram, liberated from my patent application files, which may help you visualize the interlacing process. Or not.

Is that all there is to it?

Yes. And no. That's all there is to taking a two dimensional image file and converting it to a three dimensional image file that is interlaced and ready for printing, or for making a flip from two images. But, there are a bunch of other things you should know about, and some more things for you to do. So far, pretty easy. Now comes some harder stuff.

Below I will discuss the proper preparation of your image file for 3D, and for 2D.

I will discuss, at some length, how to mount the resulting print to the flat surface of the Lenticular lens.

I will suggest some places to buy Lenticular lenses, and warn you about the numerous places that over charge.

After the picture has been interlaced, you will go into your paint program and display it on your monitor. If you've never seen an interlaced file displayed or printed, you're in for a minor visual shock. It won't look like a normal picture. It will sort of look like a double exposure. Not exactly, but kind of. Don't worry, because that is the way it should look. It looks strange because both of your eyes are seeing all the information that is available. Your left eye is seeing information that, when placed under a Lenticular lens, only your right eye should see. At this point you can make a print, and then put a lens over it and see what you have created. At first, I suggest making smaller pictures, just to keep expenses down while you go through the learning process. However, small prints tend not to be as 3D as larger ones. You can make a file that will print in the 13 x 19 inch size, and then select an area that is in the 8.5 x 11 inch size and print just that section. Or print the entire picture. Up to you. I suggest that you don't make pictures smaller than 8 x 10 inches. I have found that pictures that small don't interlace all that well. Not enough detail to make a good looking image. But you can print an 8.5 x 11 inch area of a larger picture.

Once you have a finished print, take it to a table and put it down so it is lying flat, picture side up. Then take an appropriate lens. If the picture was made to be used with a 3D 60 LPI lens, then you must use a 3D 60 LPI lens. If not, you won't see any 3D. Whether your picture is in portrait (vertical)

orientation or landscape (horizontal) orientation, the lenticules MUST be running vertically. Take a good look to visually see that the lenticules are pointing from the “bottom” of the lens to the “top”. You can also run your finger over the lenticules to make sure the lenticules are in the right orientation. As for “bottom” of the lens and “top”, the two are functionally the same, as long as the lenticules are running vertically. To help make this point clear, look at the following diagrams.

Lenticules in **correct** vertical orientation

Lenticules in **incorrect** horizontal orientation

Behind the vertical lenticules in the diagram on top are the slices of the two images created by the interlacing program. The picture information behind the black lines in the diagram are from one picture, and the picture information behind the other lines is from the second picture. If the lens is placed in the horizontal position, no 3D effect will be seen.

One aspect of Lenticular lenses which will take some time to get used to is that because the lenticules must be in the vertical orientation to get 3D, or for a flip, then a 16 inch (wide) x 20 inch (high) lens with the lenticules running in the 20 inch direction cannot be used with a 20 inch (wide) x 16 inch (high) print. You cannot solve this mismatch by rotating the lens to cover the print, because the lenticules will then be in the horizontal (wrong) orientation. So, when you buy lenses, you must take into consideration whether the lenticules are oriented for “portrait” or “landscape” mode. Photographers and artists are used to having a piece of paper that may measure 16 x 20 inches, and using it either in “portrait” or in “landscape” mode. This is not the case with Lenticular lenses. So you must plan ahead when buying lenses. There is no good solution to this fact of Lenticular life. You must learn to work within the limitations of the lenses that are available. In time, as demand rises for lenses of a particular size with lenticules in a particular orientation, this fact of Lenticular life will become easier to deal with.

Back to the print lying face up on your table. If you place the lens on top of the print, and you don’t see any 3D effect, the problem almost certainly is either that the lens is “upside down”, that is, the flat side of the lens is not touching the print, and/or that the lenticules are running right to left, not up and down. If there is no 3D, make sure that the flat side of the lens has been placed on top of the picture, and is in contact with the print. If the flat side is touching the picture, you may have to press the center of the lens gently to make good contact with the print to bring out the 3D effect. If there is still no 3D effect, rotate the lens 90 degrees, just in case the lenticules are in the wrong orientation. At this point you should see some visual changes to your image. If you still don’t see any 3D effect, there is a chance that you chose a very inappropriate subject for converting to 3D- like the flat wall with graffiti I mentioned earlier.

Let’s be optimistic, which is a stretch for me. Let’s say that there is a noticeable 3D effect. But you’d like more. You can try remaking the files with a larger “offset” if that is how you made the two different images for 3D, or reshooting the still life and moving the subject/object a bit further than you did the

first time, or sliding the print in the scanner further than you did the first time.

Regardless of how much 3D you see or don't see, over time, with practice and by incorporating the following suggestions, the 3D effect will increase.

Important preparations.

If you take blurry photographs, or make blurry paintings, you'll never get good 3D. No kidding. In the 1930s the Eastman Kodak Company started coming out with rules for the photographic print. These rules were originally devised for black and white photography, but apply to color as well. They were laid down so that the viewer would see the most 3D possible in a 2D flat photograph. Over the years more rules have been added. If you haven't studied photography, you may not be aware of these rules. And so you probably don't incorporate them into your digital pictures. You should learn to.

These rules, when using old fashioned Kodak wet photography, are just about impossible to follow. That's what separates those relatively few "master craftsman" photographers from the rest of the field. Happily, the digital darkroom makes following/applying these rules much easier, but still difficult. You just need to learn what the rules are, and then gain enough control over your paint program to apply them. And these rules also apply to paintings that have been digitized, although the painter does have a host of tools and techniques not available to the photographer, such as the ability to easily insert depth cues.

Here are the rules that the photographic print (and now digital print) should follow. The print must have:

(1) A photographic white. That is, <u>somewhere</u> in the picture is the pure white of the paper. Some white papers are whiter than others. This photographic white is the white of the paper you are using. It doesn't have to be a large area, but it must be visible.

(2) A photographic black. This is the blackest the paper is capable of becoming when properly exposed and developed. In digital imaging, this would be the blackest the ink is capable of making the paper. It doesn't need to be a large area, but a "photographic black" must be <u>somewhere</u> in your print.

(3) Highlight detail. If a person is wearing a white shirt, it should show detail-folds in the fabric. It should not look like a white piece of paper that was cut out and pasted onto the person.

(4) Shadow detail. If a person is wearing black pants, it should show detail- folds in the fabric. It should not look like a black piece of paper was cut out and pasted onto the person.

(5) There should be a zillion shades of gray in the print. Well, this was a rule before there was much color photography available. Regardless, you need the picture to have many many many graduations of tone- a picture containing many areas of solid color won't be as 3D as a picture with many many many graduations of tone- be they in grayscale or in color.

(6) The proper brightness and contrast. I can't help you on this point, because I can't come up with the words to explain what the proper contrast and brightness is, but there are books you can buy or get at a library which will show you what the proper brightness and contrast of a photographic (and now digital) picture should be. Too dark or too light or too contrasty or not contrasty enough will cut down on the 3D effect.

(7) Light that contains "modeling", which means that it helps put depth cues into the picture. The standard suggestion for a starting photographer is to take pictures with the sun over the photographer's shoulder, while the photographer is facing the subject. This is the opposite of "flat" lighting, which by its name suggests it should be avoided when trying to make 3D pictures. Flat lighting comes about in various ways. Having the sun behind the subject, instead of in front of and slightly to the side, will result in flat lighting. Avoid this. When in doubt, try to use the "sun behind you and a little to one side" lighting, but you can also use cross lighting- the light from the side, only slightly in front of the subject. Of course, you can use a photographic light or other type of light if you are inside.

(8) And don't forget, your picture should be sharp. Photographer's call really sharp pictures "tack sharp". Really sharp. A picture that is less than tack sharp won't be as 3D as the same picture that is tack sharp.

The photographer or artist who can follow these rules will end up with better 3D pictures than those who can't, or doesn't want to. If you are not a master photographer, and few people are, does this mean that you can't get really good 3D, or even respectable 3D? No. You can learn to control those aspects of photography and painting that will increase your 3D effect. You can read tutorials on the Internet, buy books, or take courses at a local community college. You could even go for a B.F.A or M.F.A in photography. Possibly a bit extreme, but up to you.

Some printing tips

Following are some techniques which I discovered by trial and error over the past few years. I'm sure that there are others I haven't discovered yet that will increase the 3D effect even further than I have been able to achieve. Do keep in mind that if you come up with a technique that seems to increase the 3D effect just a little, then that technique, when added to other techniques that seem to increase the effect just a little, combine to give a greater 3D effect to your pictures. Every little bit helps.

(1) Most people do not print their photos or art at the lowest dpi their printer is capable of printing. I have discovered that if the resolution of picture is 360 ppi (pixels per inch), which will print at 360 dpi (dots per inch), but I set the resolution the printer will print at to the highest dpi the printer can print at, the resulting picture has more 3D than when the file is printed at 360 dpi. I won't tell you why this is, because I don't know. You can try this for yourself. The increase is noticeable, but only slightly. Remember, a slight increase in the 3D effect here and a slight increase in the 3D effect there combine to make a noticeable increase in the 3D effect. As for the "I don't know", this is one of the problems of working without a large support system. When more people are doing 3D Lenticular imaging, I'd have a bunch of people to compare what I've done with what they are doing, and to exchange information and speculation with. I have also found that letting the printer interpolate the interlaced file instead of using my paint program to do the interpolating works better, and it works better than starting off working on a file with a resolution of 2880 or larger ppi. And the smaller file (360 ppi) is a lot easier to work with.

(2) Over-sharpen. I usually sharpen to the point that the displayed file on my monitor looks too sharp- a bit rough, but just a bit. This over-sharpening does increase the 3D effect, and doesn't look over sharp when the file is printed and a lens is placed over the print.

(3) I have found that the higher the LPI of the lens, the better the 3D effect. This is easy to test, by making the same picture for lenses with two different LPIs. The (current) problem is that the highest LPI lenses I can find for sale that work with my Epson printer output are 60 LPI lenses, which are okay, but I can't find 90 LPI or greater lenses, which do give (for my art, at least) greater 3D.

Where can I get Lenticular lenses?

It's obvious that without the proper Lenticular lens, you won't be able to make 3D Lenticular images, or 2D flips. If you already have a supplier you are

happy with, keep using them. If not, I wholeheartedly recommend Micro Lens Technology (http://www.microlens.com, 704-893-2109) They are a major manufacturer of flip and 3D Lenticular lenses. Their prices are very reasonable, and above all, they are happy to sell small quantities of lenses to those who only need small quantities. (You may want to call and ask them to email you a price list.) Some other companies seem only interested in selling large quantities to large printing companies. Once you start buying from Micro Lens, you'll start hoping that they don't change their attitude about selling in small quantities.

No, I don't get paid anything for writing something nice about them, and no, (unfortunately) they don't give me a discount. I'm just happy that they continue to sell lenses to me. I realize you want some idea of their products and prices. Since both are subject to change at any time, I won't go into detail about their prices and products. However, in August 2006, I bought fifteen 16 x 20 inch 60 LPI 3D lenses for $59.70. This comes out to $3.43 per 16 x 20 inch lens. These lenses are in "portrait" orientation, which means that if the full lens is used, your picture will be higher than wide. But not to worry if you want a lens in landscape orientation. For a small fee, Micro Lens will cut larger size sheets to your desired size. So you can buy larger size lenses that are in "portrait" orientation and have them cut so they are in "landscape" orientation. For example, one 16 inch wide x 20 inch high lens can be cut to give you two 16 inch wide x 10 inch high landscape oriented lenses.

Watch out for those companies that grossly overcharge for their lenses. As examples, I found a company on the Internet that sells twenty 11 x 14 inch 60 LPI (presumably 3D) lenses for $396, plus shipping. That comes out to $19.00 for each 11 x 14 inch lens. Whether the lenses are in portrait or landscape orientation isn't specified. Also, these expensive lenses have a "sticky" backing applied. I wonder how many reorders this company gets when the buyer finds out that the lenses they bought are useless for positioning the print before mounting it. Compare their $19 price each for an 11 x 14 inch lens with Micro Lens' $3.43 price for each of their 16 x 20 inch 3D lenses.

Another company sells ten 3D 60 LPI 4 x 6 inch lenses for about $225, if my memory serves me correctly. That comes out the $22.50 for each 4 x 6 inch lens. So, no matter where you get your lenses, do some comparative pricing. Some people believe that if something costs a lot, it must be worth it. I don't.

Because Lenticular imaging is relatively new, people don't know what prices should be, and where to get supplies. The two high prices mentioned above remind me of a woman I was standing next to in a computer store who was sold ten 5 1/4" floppy disks for $200 by a computer store in Los Angeles in the mid 1990s. Be careful!

Another company I have had contact with is Goex, which can be found at

http://goex.com/. Information on their web site shows that they do sell 90 LPI 3D lenses. These 90 LPI 3D lenses are 28 inches wide by 20 inches high, with the lenticules running 20 inches high. These lenses are in “landscape” orientation. Each lens could be cut to be 14 inch’s wide by 20 inch’s high, which would be lenses in portrait mode. This might be hard to visualize. If so, draw some pictures and see if that helps you understand this fact of Lenticular life. The problem is that the Goex website shows the minimum order is 20,000 pounds, which not only will cost you a lot of money for the lenses, but also for the shipping and storage. This quantity is probably enough for your next six lifetimes. I have been able to get some small quantities of lenses from Goex, but it’s always been a lot more work than I think it should have been. If you’re really good at begging...

I believe that Goex would prefer to sell large quantities to large commercial printers, than small quantities to “hobbyists” or artists. I think Micro Lens has the philosophy that a buyer of small quantities today may turn into a buyer of large quantities some time in the future, or tell someone who needs large quantities about them.

There are other manufacturers of Lenticular lenses. Some try to hide so they won’t be bothered by hobbyists and people who just want small quantities. Some other companies are located in countries outside the U.S., so the shipping costs make them too expensive for most people.

Microlens also gives a free for the asking interlacing program to those who want it. This program, called Superflip, is excellent for making flips, and can also be used to interlace images for 3D. Microlens will give you this program free, but only with an order of their lenses. For a $60 plus shipping order of fifteen 16 x 20 lenses, this is a great bargain. Most interlacing programs run in the $500 and up range. Check by typing “interlacing program” into your favorite search engine. You’ll have to check with them to see if they still give Superflip away.

Theoretical vs. practical aspects of Lenticular lenses.

I suppose that all the manufacturers of Lenticular lenses say that their’s are made with the highest quality materials, and are checked numerous times during manufacture, etc. And they may be. But there are a number of practical considerations you should keep in mind.

(1) How many LPI are there really in a 60 LPI lens? Some interlacing programs contain a “pitch test”, which is a way to determine, so the software publisher says, the true number of LPI in a Lenticular lens. It may turn out that a particular batch of 60 LPI lenses actually have only 59.4

LPI. This may seem like a major problem, since I have told you the objective is to make extremely precise slices from your original picture(s) so that only the left eye sees the left eye information, and only the right eye sees the right eye information. If the slices are made on the assumption that there are 60 lenticules per inch, and there are less (or more), then eventually some left eye information will end up under a right eye lenticule. Some manufacturers will notify the buyer that the true LPI of their current batch of 60 LPI lenses is 59.4 LPI, and then tell the buyer what to multiply (enlarge or reduce through interpolation) the finished interlaced file by to make a correction. And as mentioned, some interlacing programs will help you determine the "true" LPI of your lenses, and automatically make the correction for your interlaced file for you. I am of the belief that the corrections are not necessary. Why? From logic and practical experience.

(2) First, Lenticular lenses are made out of plastic. Plastic is unstable. Temperature and humidity changes can cause the lens to shrink or expand some. There goes the precision that using a correction factor is supposed to control.

(3) Then there is the problem that the lenticules may not be absolutely vertically aligned. It is possible that they are "tilted" a very small degree. If this is the case, then some left eye information will eventually end up under a right eye lenticule. This "tilting" may happen during the manufacturing process, but is more likely to happen because lenses are usually cut down from much larger sheets. If a standard manufactured sheet size is 32 wide x 40 inches high, and the manufacture or reseller cuts it down to make four 16 x 20 inch lenses for sale, then the chance that the lenticules are absolutely vertical is slim, due to any very small cutting error. This is a problem that isn't a problem. When you place a lens over your print, and align it so it appears to be squared up, so one edge of the lens is touching one edge of the print, you will find that if you then slightly rotate the lens, you will see the 3D effect change. It might get greater. Or less. I always rotate my lens over my print to get the best result possible. Additionally, slide the lens a small distance left to right, and see what changes that makes to the effect, as you change the information that is behind the various lenticules. Trying to use a mathematical fix just isn't necessary. (You can if you want to and think you know how. That's up to you. I can hear various experts in the field arguing with what I've just written. All I know is what my eyes tell me.)

(4) Add to all this the question of whether your printer is printing absolutely vertical and parallel lines (and of the same thickness). Newer Epson

printers claim to do this with the aid of a laser tracking device. I don't know how well that works. I do know that most printers don't have sophisticated means for constantly checking the "trueness" of the lines they print. So the lenticules in the lens may be perfect, but the information in the interlaced sections of the file may have problems of their own, due to imperfect printing.

(5) Over time, as more people get involved with 3D Lenticular picture making, these problems, if they really are problems that need a fix, will be addressed by companies that want to make money selling fixes.

(6) A final point I want to make about Lenticular lenses is that it is possible to buy them with an adhesive applied to the flat back. DON'T. EVER. More about this below.

Now for the REALLY REALLY REALLY REALLY HARD PART OF THE PROCESS.

No kidding!

You have made a print and placed it face up on a table. Then you have placed a Lenticular lens over it, shifted the lens to the left or right a smidgen, and rotated the lens a bit, and are satisfied with the results. Now what? Leave it there forever? Or maybe attach the print to the back of the lens. Well, that's the problem. Somebody, somewhere, is going to get rich figuring out a simple and effective way to do just that, if it doesn't cut down on the 3D effect.

Why is this such a problem. Because if the front of the print or the back of the lens is sticky, then there is no way to place the lens on the print and move it slightly left to right and rotate it slightly, to get the best possible alignment. It can't be done if the lens or the print is sticky. I got so frustrated trying to come up with a good way to mount prints onto lenses that one day I almost literally started to bang my head against a wall. I decided instead to log on and see if I could find something on the Internet. I did find a company that made custom made adhesives. I thought if I could explain the problem, they may have a way to make a clear non-destructive adhesive that wasn't tacky until pressure or something was applied. I called and talked to the owner of the company. I started to explain what Lenticular imaging was. I started to, and he interrupted me and said, "Lenticular? I know all about Lenticular. Do you know why that never took off? **It's because they're impossible to mount!**" I just looked at the phone in my hand. Then I said goodbye and thought about banging my head against the wall again.

As I briefly mentioned, it is possible to buy Lenticular lenses that have had an adhesive applied to its back. **Avoid this!** Unless you have spent the

thousands of dollars for the machinery designed to precisely apply the print to the adhesive backed lens, you will end up with one heck of a mess. The adhesive is akin to clear fly paper. It is super sticky.

Laminating is the method used by some companies and some individuals who have the money to invest in the proper type of laminating machine. A thin sheet of laminating material is positioned between the front of the print and the back of the lens, and then heat/pressure is applied. Besides cost, the thin laminate does move the print a small fraction of an inch away from the lens. This will cut down on the maximum amount of 3D you can get. I have not gone this route. For more information about laminating, you might want to check around the Internet, and/or check with the nice people at Microlens and ask for their recommendations.

Glue works fine, maybe, but is rather messy. I say maybe because I don’t know if the glue will eventually attack the paper or plastic lens, causing a stain or discoloration. I have prints I glued three years ago, and they look just fine and dandy, but I don’t know what they will look like in another few years time. The method I’ve devised for gluing is as follows:

I put the print on a table face down. I take a strip of (acid free) artists’ tape and run it along the top of the print, so that about half the width of the tape is on the print, and the other half is above the top of the print. I then turn the print over, and place some wax paper over the tape, which is now facing up. With the tape covered, I can place the lens over the print and slide it left-right and rotate it slightly, getting the best 3D that picture is capable of being. When I am satisfied, looking to see that the print is pretty much centered on the lens, I put my fingers on the lens and push down, and then pull the wax paper out, which results in the tape sticking to the lens. I then apply a little pressure where the tape is, just to make sure the tape is stuck to the lens. With the print taped to the lens, I can turn the two over, so the print is on the top. At this point I am looking at the back of the print. I then bend/fold the print over, using the tape as a hinge. Now the print is facing upward, and is mostly off the lens. Then, I take some type of scrap paper, such as brown wrapping paper, and place it over the exposed back of the lens, making sure to put some paper also at the edges of the print where the hinge is. Then, using either 3M Spray Mount Artists’ Adhesive or 3M Photo Mount spray glue, I give the front of the print a good spraying. When I think I have covered the entire front surface of the print, I remove the scrap paper which was protecting the lens from the spray, and then I fold the print onto the lens, and use a small plastic burnisher or squeegee to get the print into good contact with the lens. And that’s pretty much it.

I am taking it on faith that the glue, meant to be used on art or photographs, is relatively benign. Over the years I have had a few of these mounted prints start

to become unglued. Also, the room I use the spray glue in is, well, sticky. Finally, the glue does put a "new surface" on your print, which might take you some time to get used to. There has to be a better method. Eventually there will be enough demand that some company will come up with a non-tacky glue that is easy to apply and not messy, and won't cut down on the 3D effect.

Framing is the absolutely best solution, although it is also the most expensive over time. Start off as if you are going to spray glue the print to the lens, but once the print is taped into position onto the lens, skip the folding and glue part. The problem at this point is that the print will not stay in good contact with the lens unless pressure is applied. So leaning the print and lens up against a wall, or whatever, to view it won't do. I think the best way to proceed is to use a "temporary" frame. Buy an inexpensive frame of the size that will easily take the size of the lens you are using, and that is easy to open and close and reopen many times, so it can be reused without wearing out. Place the print taped to the lens into the temporary frame. I suggest you forget about a mat. Hang the picture, and live with it for a while. If you decide that you don't love it enough to pay for a proper matted framed picture, you can remove the lens from the frame, and put it somewhere for storage, with the print still taped into position. After a while you may have a nice stack of pictures living on the floor in a corner of a room. Revisit them from time to time, and you may discover that some are masterpieces. If you decide that a picture is a masterpiece, frame it with the tape holding the print in position with the lens. If it's an acid free tape made for use with art, I wouldn't be concerned about it causing the demise of the art. If you decide that a 3D or flip picture is a masterpiece, and worth framing, then frame it yourself or take it to a framer. Leave the tape in position, which will keep the picture in proper position, and let a mat cover the tape and hide if from view. Or let it show. I have my "masterpieces" framed. Of course, you can remove the print if you don't like it at all, and reuse the lens. If you reuse the lens too many times, it will become scuffed, and that will cut down on the 3D effect.

As for the Longevity of the lens and print:

The longest tests I've run have all been accidental tests. For example, over three years ago I gave my wife some 8 x 10 inch spray glued 3D art to take to her office, and then I promptly forgot about them. A few months ago I was at her office, and noticed that the prints were on a shelf next to a window- the prints were leaning against the window glass. Daylight, and at some times during the year, sunlight, struck the back of the prints. After a few years of this, I can't detect any problems with either the lenses or the prints. In fairness, my wife has told me

that the window glass does have a UV protective filter. Make sure to use a quality UV protected glass in your frames.

Summary, of sorts

1) Some Lenticular lenses are made for flips, and others are made for 3D. Don't try to use one lens type for a different type of Lenticular picture. They don't mix and match.

2) All that is necessary to make a flip is two or more digital images that are the same size and resolution (dpi), and an interlacing program that will interlace the files for the type of lens (LPI) you will use for the final picture. Well, depending on the interlacing program, pictures of different sizes can be used because the program will resize the files. I believe, from experience, that this automatic resizing does adversely effect the quality of the final image.

3) To remind you, LPI stands for Lenticules per inch. I have found that the greater the LPI, the greater the 3D effect, all things being equal. At present, 60 LPI lenses are "standard" for 3D, but higher LPI lenses can sometimes be found. If you do find higher LPI lenses, make sure they are made for 3D if that is what you are doing, and not for flips, unless that is what you are doing.

4 The easiest way to make a 3D file ready for interlacing, is to use the method of **offsetting** described above. With this method any picture, whether it is a photograph or drawing or painting, can be made into a 3D Lenticular image. And in very little time, and at zero expense (assuming that your paint program can "offset" an image, which most can). When describing the "offset" method, I wrote that the number 8 should be entered in the appropriate field for the number of pixels to offset the second (right eye) image from the first (original-left eye) image. The number 8 is only a starting point. Some experimentation on your part will be called for. I have found that numbers ranging from 6-10, including odd numbers, seem to work for most images. If you don't offset enough, you won't get much of a 3D effect, but if you offset too much, the resulting print when placed under a Lenticular lens will seem to "jump" from left to right. Kind of vibrate. Different types of pictures will generally benefit from different amounts of offset. A close-up picture (like a portrait) will benefit from a larger offset than a landscape with a lot of small detail, which will benefit from a smaller offset.

5 Choose the image you want to make into a 3D Lenticular picture based not only on its aesthetic value, but also the amount and number of depth cues it

contains. The more, the better. Photographs or paint pictures with a distinct foreground, middle ground, and background will give you the best 3D.

6 Don't forget to incorporate the "rules" as set down by Kodak for a photographic print, which hold true for a digital print. Following them will increase the 3D effect. If you make blurry pictures, you won't get good 3D, no matter what lens you use and what interlacing program you use and how many depth cues you have in the picture.

7 I have found that printing the interlaced file at a greater dpi than the resolution (ppi) indicated, does (slightly) increase the 3D effect. So, if the resolution of the file is 360 ppi, tell your printer to print at 1440 or 2880 or the maximum dpi that printer can print at, instead of 360 dpi. If the resolution of the file is 600 ppi, tell your printer to print at 1200 or 2400 dpi, or whatever the maximum dpi that printer can print at, instead of 600 dpi. True, you can use your paint program to "enlarge" the file instead of letting the printer's software do it, but that creates one very large file, which might get into the gigabyte or larger range, so I let my Epson 1280 printer software do the "enlarging".

8 Don't forget to have the lenticules running "up and down", not "left to right".

9 Bigger is better, especially in 3D Lenticular pictures. Pictures smaller than 8x10 may not have enough detail to look good, and even 8x10s are pushing the lower boundary for Lenticular 3D pictures. You can make flips smaller, but they too look better bigger.

10 Superflip is a (currently) free interlacing program available from Microlens (http://www.microlens.com), when you make a purchase.